# Space Weather Technical Forecast

Issued on Sunday, 30 April 2023 at 13:09 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

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**Space Weather Forecast Headline: Chance of R1/R2 throughout. Active electron fluence expected. Slight chance of G1, mainly Day 3 (02 May).**

## Analysis of Space Weather Activity over past 24 hours

**Solar Activity:** Solar activity over the past 24 hours has been Low, with occasional C-class flares, mostly from AR3288 and AR3289. The largest was a C7.4 flare peaking at 30/0849 UTC. There are currently five sunspot regions on the visible disc. The largest and most complex region on the disc remains AR3288 located in the southwest quadrant, with a clear delta region in the intermediate spots. In close proximity is AR3285 which may also help to increase magnetic instability. AR3289 has seen slight growth in its northern spots, with a weak delta forming in the trailing spot. The remaining regions are small and more simple at present.
There have been various mainly weak and faint eruptions appearing in coronagraph imagery in the last 24 hours. Generally speaking, any CMEs are considered most likely to miss Earth, although some glancing influence from several different sources cannot be ruled out in the coming days. As a result, the forecast should be considered of lower than average confidence at present.

**Solar Wind / Geomagnetic Activity:** The solar wind, as observed by ACE at L1, was reflective of a waning High Speed Stream (HSS) from CH96/-. The wind speed started the period at strong levels, mainly between 580-720km/s, easing to become elevated around 500 km/s. Density was mostly below average. The IMF, Bt, was weak below 6 nT, with the north-south component, Bz, varying weakly between +4/-5 nT. The phi angle has been mostly negative (towards the Sun). Geomagnetic activity was Quiet to Active (Kp 1-4).

**Energetic Particles / Solar Radiation:** High energy proton flux (greater than 10MeV) as measured at GOES16, has been at background levels throughout.
High energy electron flux (greater than 2MeV) as measured at GOES16, has been at mostly High levels, peaking at 13000 pfu at 29/1645 UTC. The 24-hour integrated fluence was at Active levels on a rising trend, with 4.0e8 integrated pfu recorded at 30/0000 UTC.

## Four-Day Space Weather Forecast Summary

**Solar Activity:** Solar activity is likely to remain Low, with a chance of reaching Moderate levels through the coming days.

**Solar Wind / Geomagnetic Activity:** There are several CMEs in the forecast which are mostly expected to miss Earth, but with the possibility of some glancing influence at various times throughout the forecast period. The CME with the highest chance to glance Earth may give some weak influence later on Day 3 (02 May). This is still low confidence, however. Otherwise, the fast wind from CH96/- is slowly starting to wane, and this should continue to ease further through the coming 24 hours. However, CH98/- may give some limited influence, perhaps prolonging slightly elevated wind speeds into Days 2 and 3 (01-02 May), before a more sustained reduction.

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# Met Office Space Weather Technical Forecast

Geomagnetic activity is expected to be Quiet to Unsettled, with a chance of Active intervals on Day 1 under waning HSS influence and again on Day 3, should we see any CME influence. There is a slight chance of G1/Minor Storms, mainly on Day 3.

**Energetic Particles / Solar Radiation:** Overall no solar radiation storms are expected, but there is a slight chance of a storm occurring, mainly due to AR3288, with some small contribution from AR3289.
High energy (greater than 2MeV) electron flux at GEO is at mostly High levels, and is expected to continue to reach High levels through the coming days. Electron fluence is currently above the Active (1e8 integrated pfu) threshold and is most likely to stay that way through the period, with a possible rising trend on Days 1 and 2 (30 Apr - 01 May).

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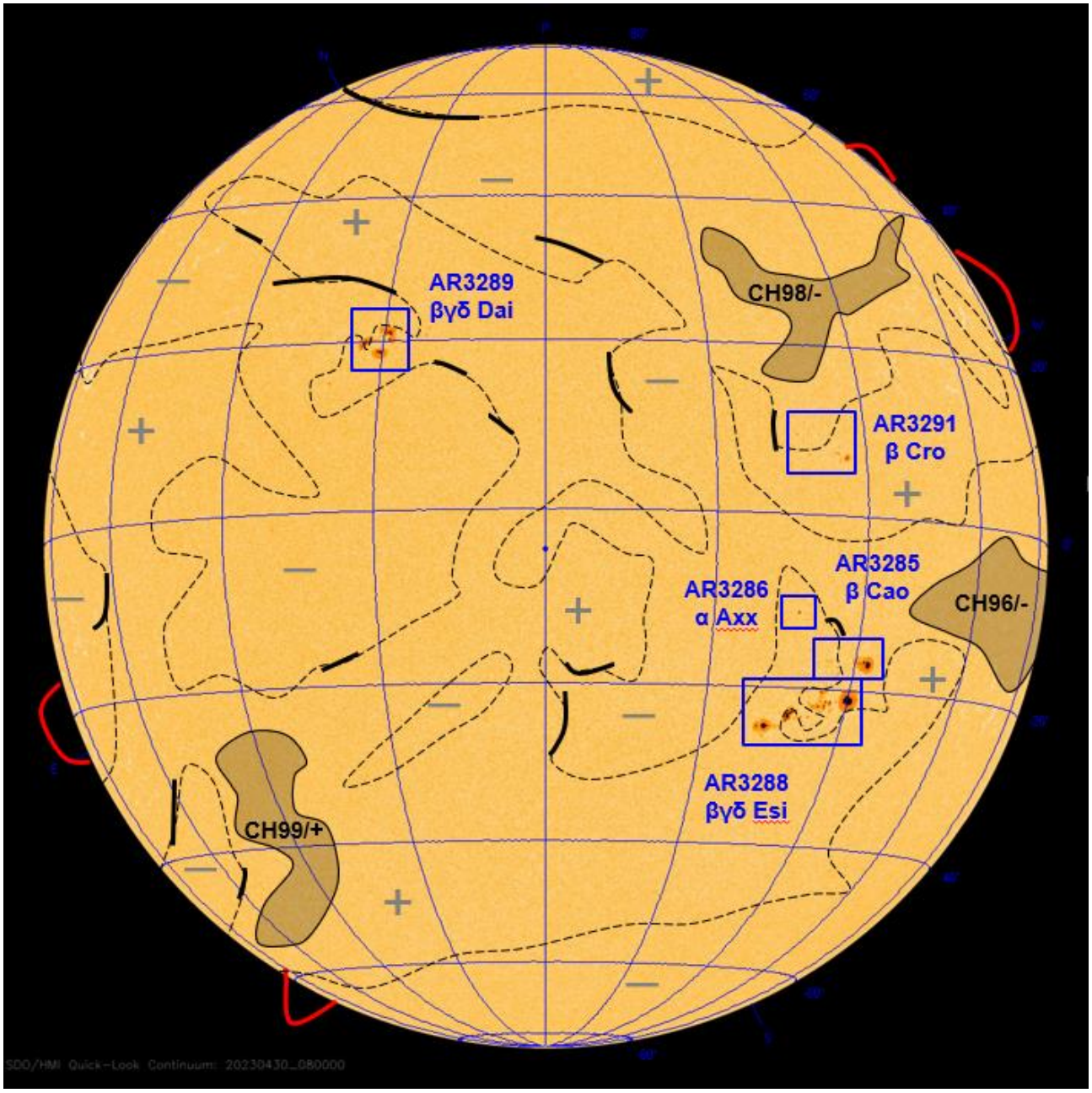
**Figure 1. Solar Analysis Valid 30/0800 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

There have been numerous mainly faint filament eruptions appearing in coronagraph imagery over the past few days. These various CMEs are mostly expected to miss Earth, but with the possibility of some glancing influence at various times throughout the forecast period. The CME with the highest chance to glance Earth was emitted early on 29 April from near AR3288, with the northern flank of this CME perhaps giving some weak influence at Earth later on Day 3 (02 May). This is still low confidence, however.

Otherwise, the fast wind from CH96/- is slowly starting to wane, with wind speeds now down to elevated levels. This should continue to ease further through the coming 24 hours. However, CH98/- is currently in the northwestern disc. It is situated well to the north and as such the bulk of any HSS will pass above Earth, but it is possible that we may see some limited influence from this feature. This may prolong slightly elevated wind speeds into Days 2 and 3 (01-02 May), before a more sustained reduction.

Geomagnetic activity is expected to be Quiet to Unsettled, with a chance of Active intervals on Day 1 under waning HSS influence and again on Day 3, should we see any CME influence. There is a slight chance of G1/Minor Storms, mainly on Day 3.

| Geo-Magnetic Storm<br>Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 5 | 5 | 20 | 5 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 29/1002 | Partial | AR3288 | SW | 510 km/s | 02/1700 UTC | Possible glance. Low confidence. |

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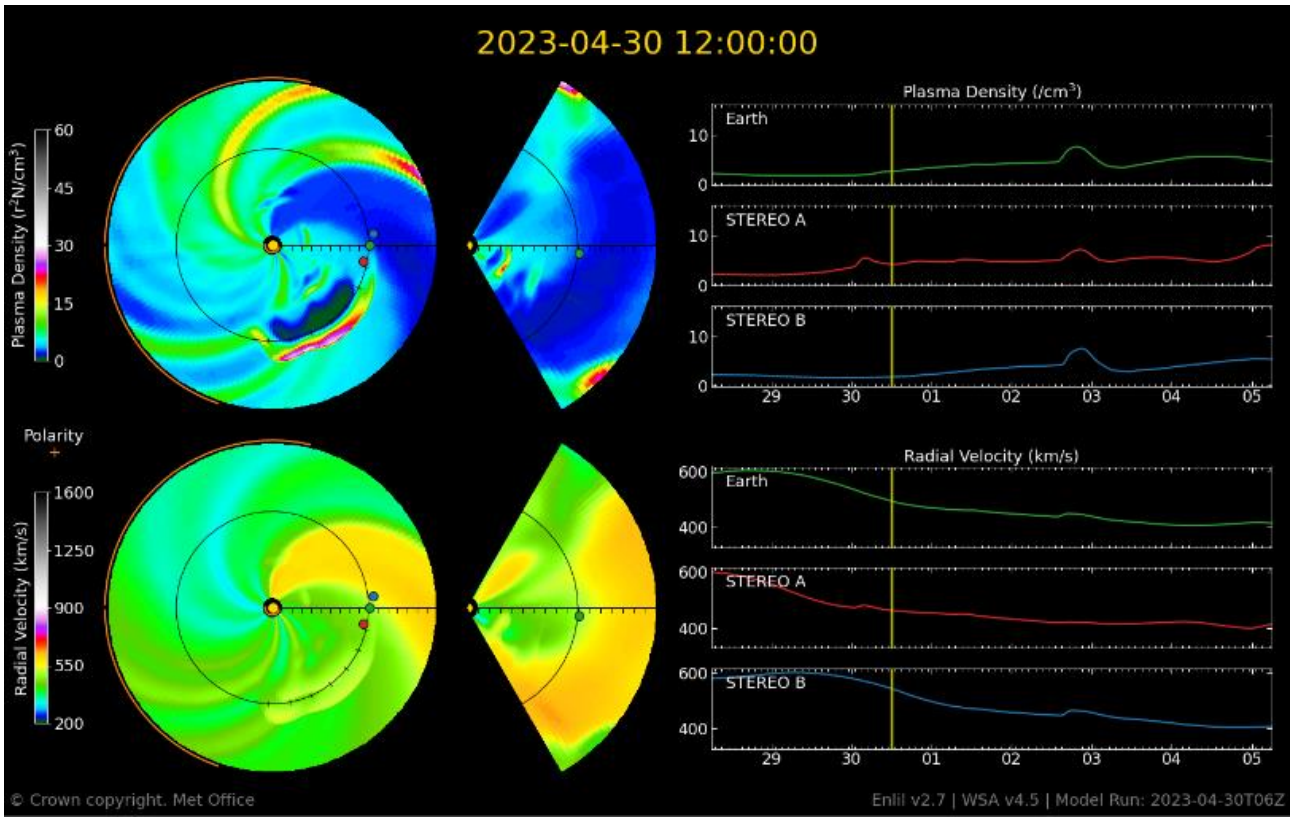
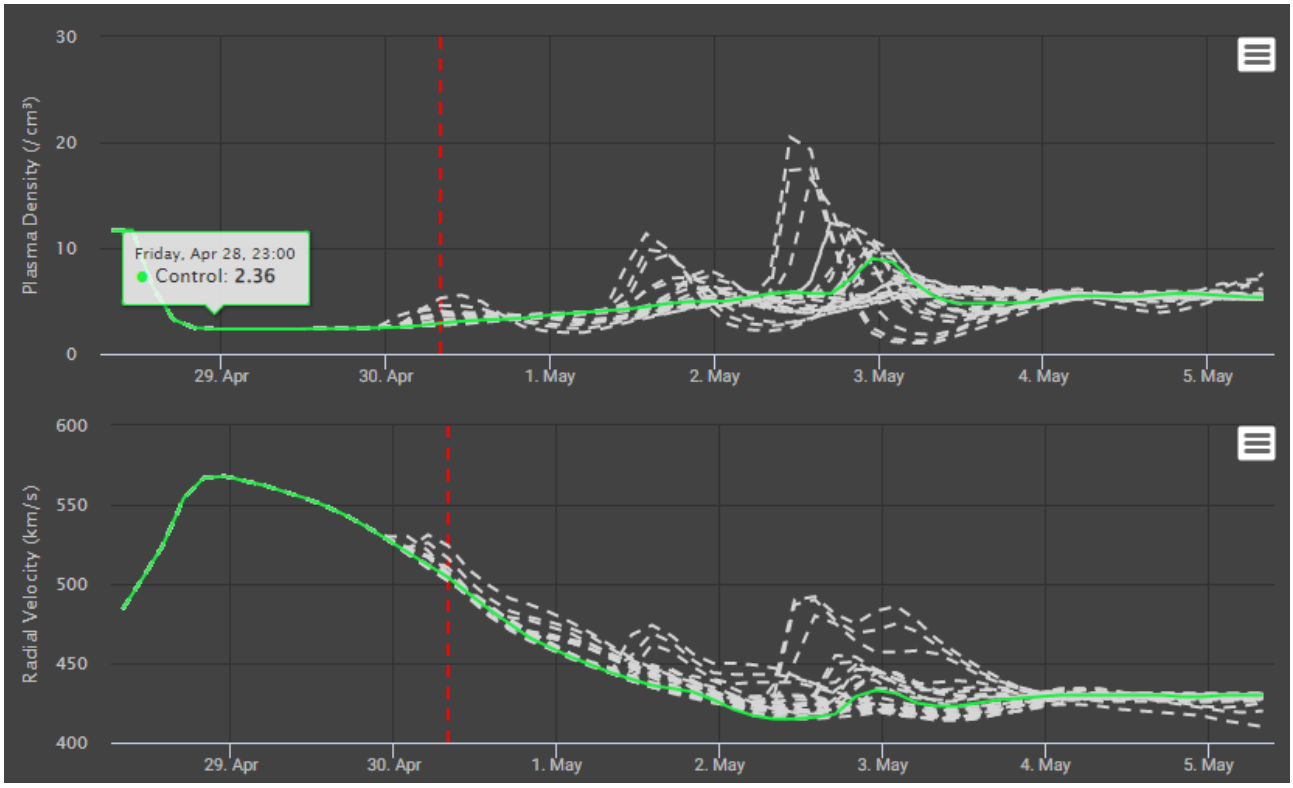
**Figure 2: MOSWOC Enlil and ensemble. The ensemble shows a low risk of various CME glancing blows through the period, but with the highest risk later on 02 May. Enlil is forecasting the HSS from CH98 to miss above Earth.**

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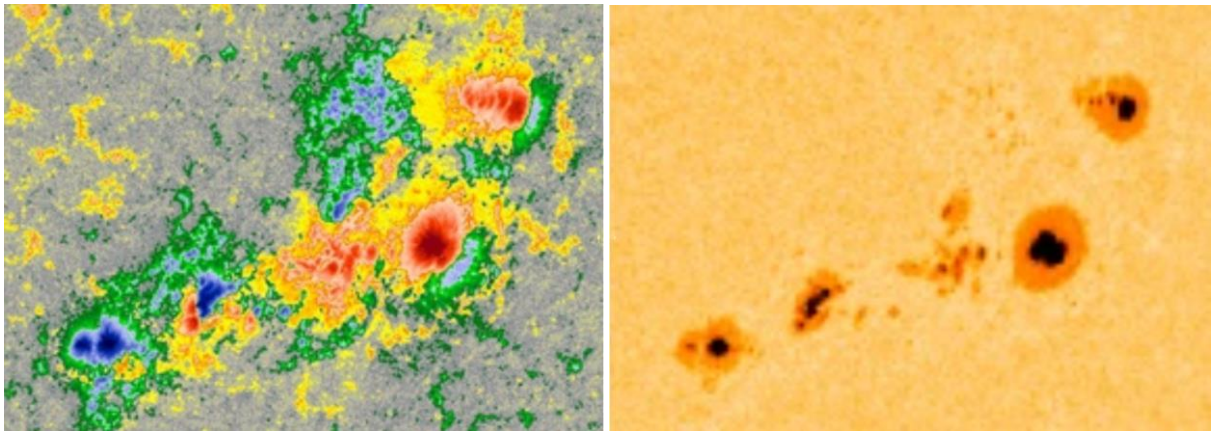
**Radio Blackouts - X-Ray Flares:**
There are currently five sunspot regions on the visible disc. The largest and most complex region on the disc remains AR3288 (Esi/Beta-Gamma-Delta), located in the southwest quadrant. Evolution and growth is evident in the intermediate spots, with a clear delta forming within this area. In close proximity to the north is AR3285 (Cao/Beta) which may also help to increase magnetic instability. AR3289 (Dai/Beta-Gamma-Delta) has seen slight growth in its northern spots, with a small and weak delta forming in the trailing spot, although this appears to be fading. The other two regions are small and more simple at present.

Currently, there is some limited activity showing from near the northeast limb, but it is difficult to assess the likelihood of flaring from this until it becomes visible. None of the near sided regions are due to rotate off. As such, flare risk has been kept flat through the four days. There is a chance of M-flares, and just a slight chance of X-flares, mainly from AR3288 but perhaps also from AR3289.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | No | 40 | 40 | 40 | 40 |
| Very Active | R3 to R5 X Class | No | 5 | 5 | 5 | 5 |

**Figure 3: SDO magnetogram and intensitygram showing AR3285 (top) and AR3288 (bottom). It shows a clear delta in one of the intermediate spots of AR3288.**



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**Solar Radiation Storms - (High Energy Protons):**
No solar radiation storms are expected, but there is a slight chance of a storm occurring over the four days due mainly to AR3288, with some small contribution from AR3289.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 5 | 5 | 5 | 5 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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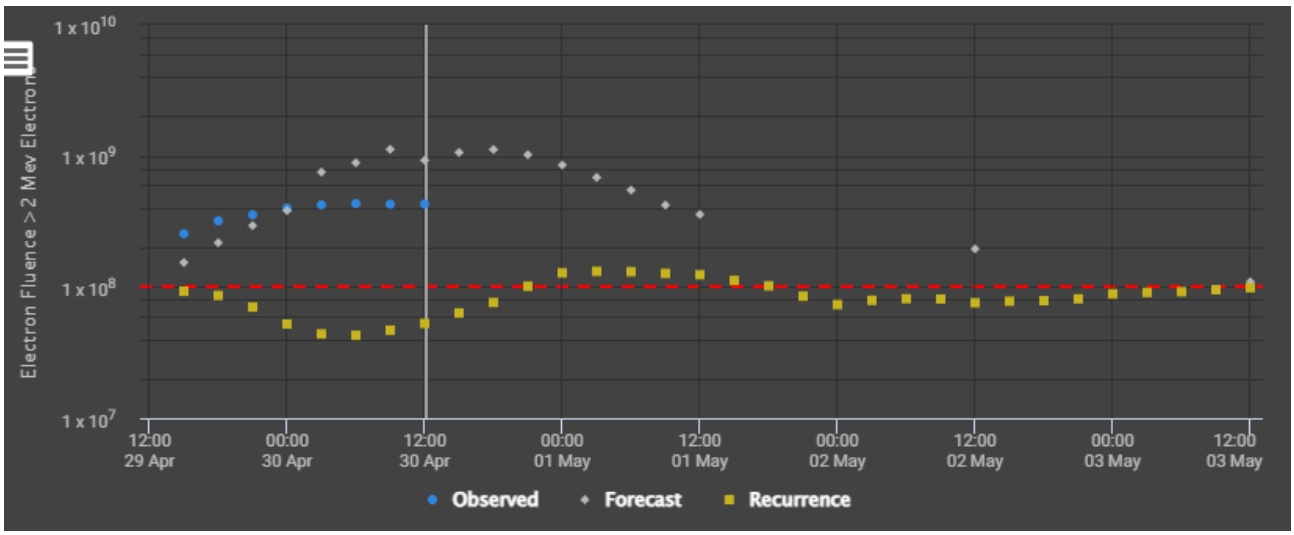
**High Energy Electrons Event (≥ 2MeV):**
High energy (greater than 2MeV) electron flux at GEO is currently at High levels, and is most likely to continue to reach High levels through the coming days. As the current HSS wanes, it is possible that electron flux will initially increase further. However, on Day 3 (02 May) there is the possibility of glancing CME influence, which increases uncertainty in the forecast in the second half of the period, and could potentially lower flux levels should it occur.

Electron fluence is currently above the Active (1e8 integrated pfu) threshold and is most likely to stay that way through the period, with a possible rising trend through Days 1 and 2 (30 Apr-01 May). MOSWOC REFM is also forecasting an above Active trend, increasing confidence in the forecast. Confidence reduces somewhat from Day 3 (02 May) however, when there is the possibility of CME influence reducing fluence levels.

| GEO Electron Environment | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Active | ≥ 2 MeV ≥ $1x10^8$ | Yes | 100 | 90 | 80 | 70 |
| Very Active | ≥ 2 MeV ≥ $1x10^9$ | No | 5 | 10 | 10 | 5 |

**Figure 4: MOSWOC REFM showing fluence well above Active currently, and forecasting above Active.**

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